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BUREAU OF AERONAUTICS PROJECT AROWA (TED-UNL-MA-501)
"Applied Research; Operational Weather Analyses"

# Final Report on Task 22

## PART ONE

# A STUDY OF THE PROBABILITY OF PREDICTING CLEAR SKIES AT CERTAIN STATIONS FROM PERIPHERAL DATA

BUREAU OF AERONAUTICS PROJECT AROWA
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## ABSTRACT

The problem of predicting clear sky conditions at twenty-two specified stations on the Eurasian continent was investigated. This was a difficult problem since the forecasts were to be made on the sole basis of observations from adjacent seas.

Surface weather charts covering a 48-year period were examined for certain meteorological features which make prediction possible. The overall probability of predictable clear weather turned out to be only .11. Greatest success was obtained at Chinese Stations in the winter season.

Data are presented for each station and each month of the year.

# PREFACE

Task 22, assigned to Project AROWA by the Chief, Bureau of Aeronautics, required the investigation of the meteorological suitability of a guidance system being developed for the guided missile "Triton" at the Applied Physics Laboratory of Johns Hopkins University.

There were two parts to this research requirement:

a. The percentage of time during which satisfactorily clear weather EXISTS over potential target areas, as a function of time of day and time of year, and

b. The factor of probability with which clear weather conditions CAN BE PREDICTED for the above areas, based on weather data expected to be available under tactical conditions.

This part of the research is an answer to b. It was accomplished within a six-week time limit.

This study was prepared under the direction of the Officer in Charge, Commander E. T. Harding, USN, by Lieutenant Commander P. M. Wolff, USN. Assisting in the preparation of the final report and in making the 385,000 forecasts involved were the following Project personnel:

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## INTRODUCTION

The problem involved in the selection of clear days at the twenty-two stations (shown in Figure 1) is more one of pattern extension than of prediction in the normal sense. For several years Project AROWA has been conducting research on the feasibility of determining meteorological conditions in an area from which data are not available. Many of the techniques used here were developed by this Pressure-Height Prediction Project.

Although the basic problem is one of extending the pressure pattern into a "silent area" from observations made over an adjoining ocean, it may be considered a forecast, in that once favorable conditions are established, they may be expected to persist for at least six hours.

During most cloudy days the lowest layer of clouds is relatively near the ground. Therefore a favorable surface pressure pattern is a necessary condition for clear periods. Conveniently, a set of analyzed surface charts covering the Northern Hemisphere is available, one for each day of the periods 1899-1939 and 1945-1952 (48 years in all).

The assumptions on which this study is based can be summarized as follows:

1. Clear weather is associated with surface pressure pattern.
2. Observations are available from ocean areas but none from the Eurasian continent.
3. One prediction per day for 48 years of record constitutes an adequate test.

## METHOD

Examination of climatological records along with surface pressure charts revealed a number of meteorological model situations which were accompanied by clear skies at the twenty-two stations. These models differed according to the location of the stations.

As stated above, it was required that favorable conditions be discernible from direct observations at ocean locations or by strong meteorological inference from ocean data. This requirement, of course, made prediction difficult in the case of stations located far from waters accessible to the fleet.

Clear acetate overlays with the twenty-two stations marked upon them were prepared. When these were placed over each chart of the series, stations located in meteorological situations favorable to the occurrence of clear weather were noted. Then the actual weather at each favorably situated station was examined. If .1 or less cloudiness was observed, the forecast was considered successful. Approximately 42,000 forecasts met these requirements.

## RESULTS

The particular method applied results in an assessment of the probability of predictable clear weather when only peripheral data

are available. This assessment ignores the other categories of clear weather: random clearing in a cloudy area, and clearing with weather conditions which cannot readily be ascertained from adjacent observations. The percentage of total clear days that can be established by this method varies with geography and season and is therefore difficult to obtain. It is highest for the Chinese Stations in winter where only a few clear days are not predictable.

The results are summarized in Table I and in Figures 2 through 9. When the data for all stations and all months were combined the resulting overall probability was .11.

$$\frac{\text{favorable station days}}{\text{total station days}} = .11$$

That is, the probability of predictable clear weather at one of the twenty-two stations on any day is .11.

When the best 5 years at each station are combined the probability rises to .28. These years are not consecutive.

When the poorest 5 years at each station are combined the probability falls to .02.

The probabilities for each station individually are shown in Table I and in Figures 2 and 3. The best station is Number 5, the

poorest stations Numbers 9, 19, and 22.

Figures 4 through 9 show the monthly probabilities for each station in graphical form. The Asian stations show best conditions in midwinter. The Southern Russian stations are best in fall, while the Northern Russian stations are quite poor throughout the year.

As was stated in the Preface, this study was completed in six weeks. With more time to develop additional satisfactory models, some improvement could be expected in the probabilities for the Russian stations. But the limit in such improvement would probably still leave an average probability of less than .10. It is believed that the models for the Asian stations would show little improvement.

The reader is referred to Part Two of this report for certain climatological and theoretical aspects of the use of the type of guidance system under study.

TABLE I

PROBABILITY OF A PREDICTABLE CLEAR DAY

| Station | Average Total Probability | Best 5 years Total Probability | Worst 5 years Total Probability |
|---|---|---|---|
| 1 | .14 | .34 | .00 |
| 2 | .22 | .50 | .02 |
| 3 | .20 | .41 | .02 |
| 4 | .27 | .48 | .08 |
| 5 | .40 | .64 | .17 |
| 6 | .33 | .59 | .10 |
| 7 | .06 | .23 | .00 |
| 8 | .05 | .25 | .00 |
| 9 | .01 | .06 | .00 |
| 10 | .04 | .20 | .00 |
| 11 | .10 | .32 | .00 |
| 12 | .05 | .21 | .00 |
| 13 | .08 | .30 | .00 |
| 14 | .07 | .25 | .00 |
| 15 | .08 | .27 | .00 |
| 16 | .08 | .26 | .00 |
| 17 | .03 | .12 | .00 |
| 18 | .03 | .12 | .00 |
| 19 | .02 | .12 | .00 |
| 20 | .03 | .13 | .00 |
| 21 | .03 | .14 | .00 |
| 22 | .02 | .12 | .00 |
| averages for all stations | .11 | .28 | .02 |

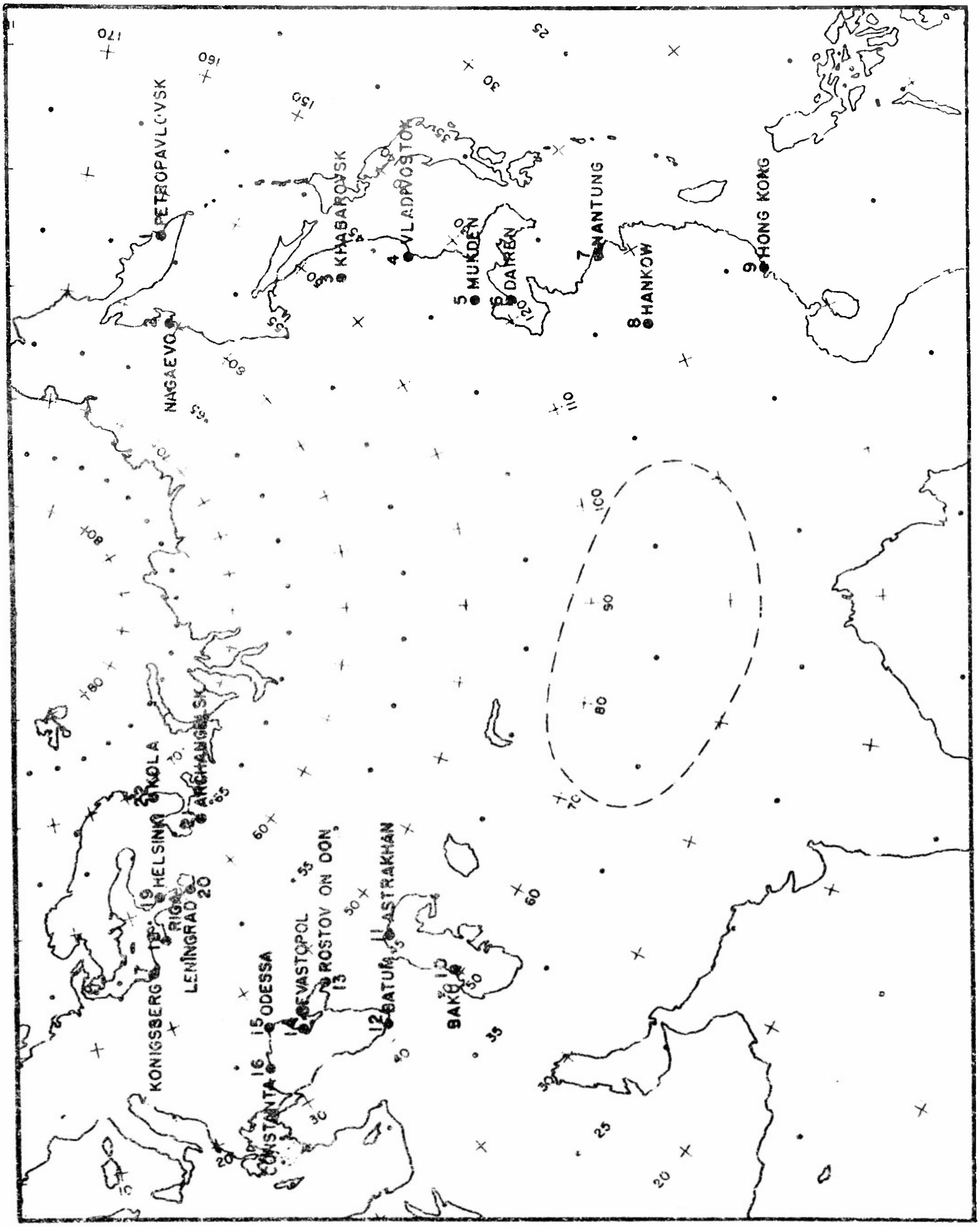



Figure 1: The Twenty-Two Eurasian Stations.

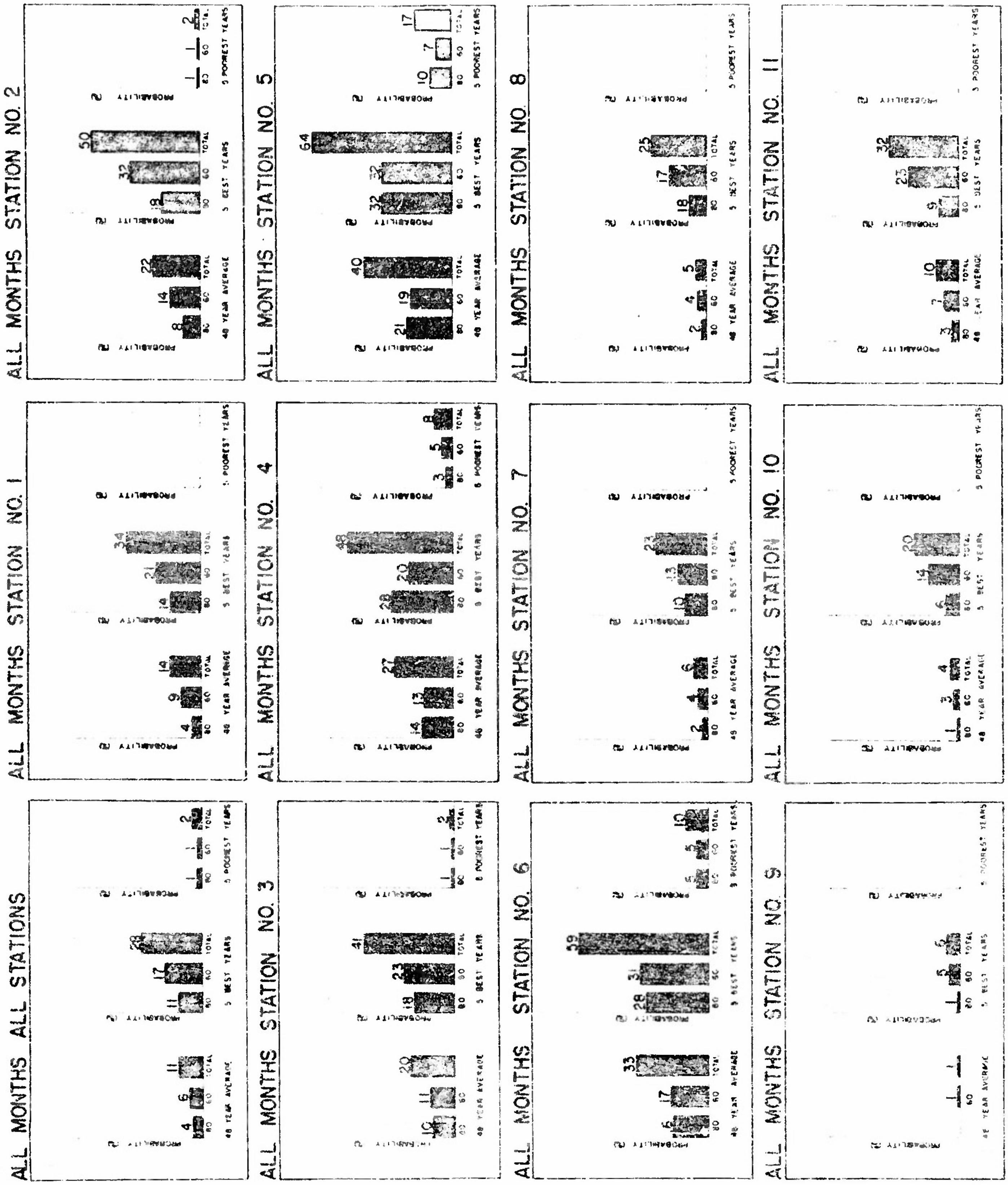



Figure 2: Overall Probabilities; Yearly Probabilities For Stations 1-11.

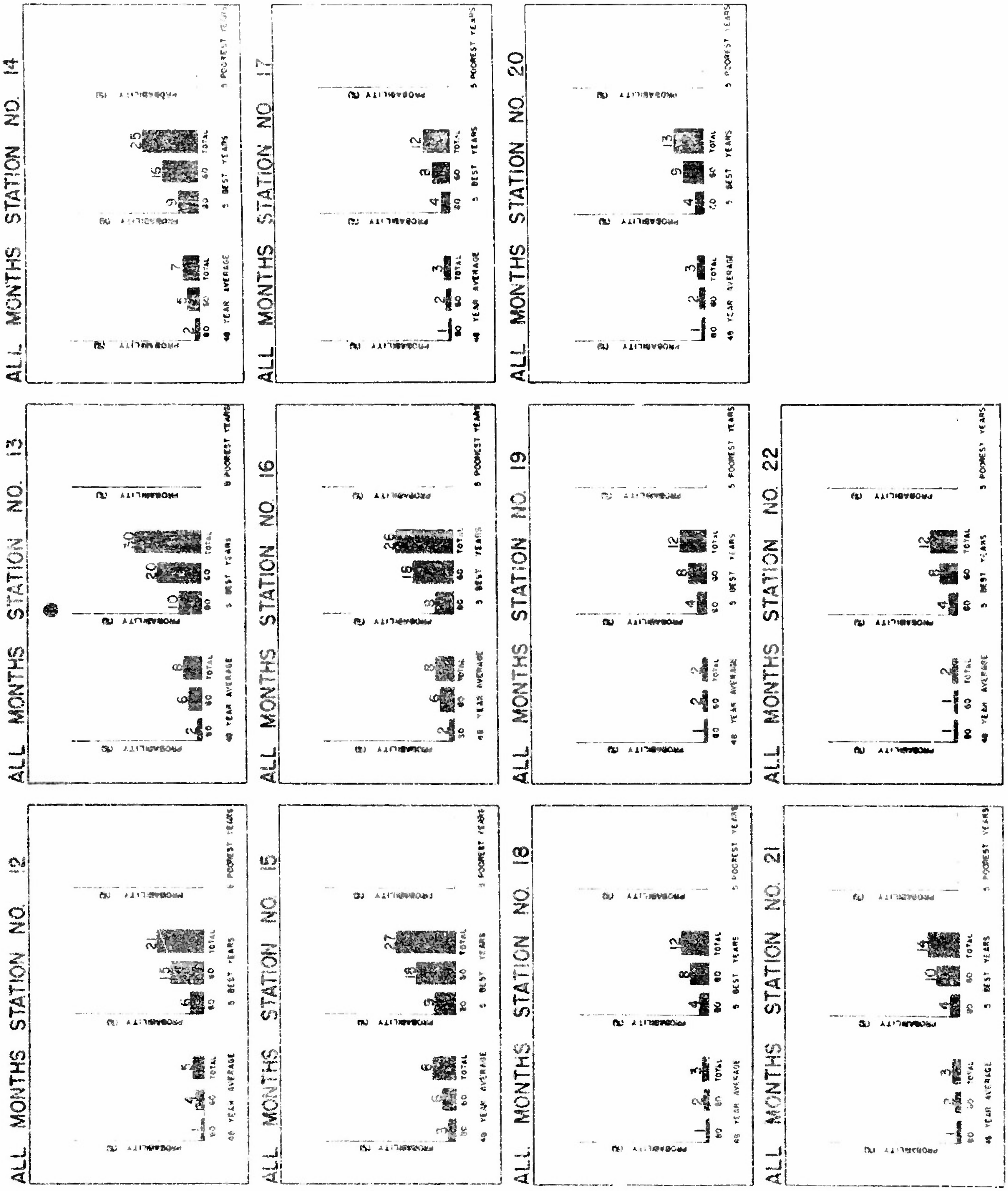



Figure 3: Yearly Probabilities for Stations 12-22.

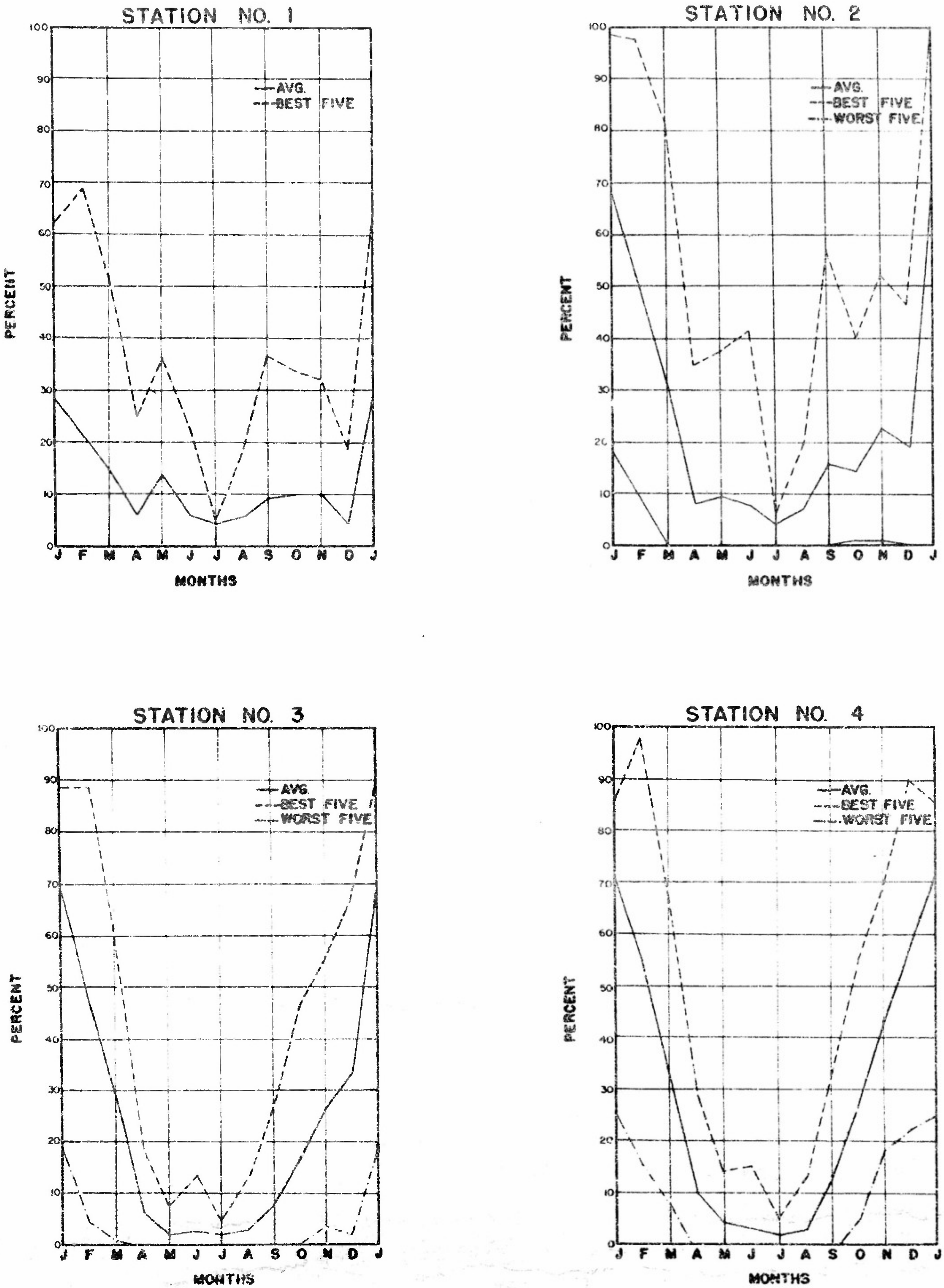





Figure 4: Monthly Probabilities for Stations 1-4.

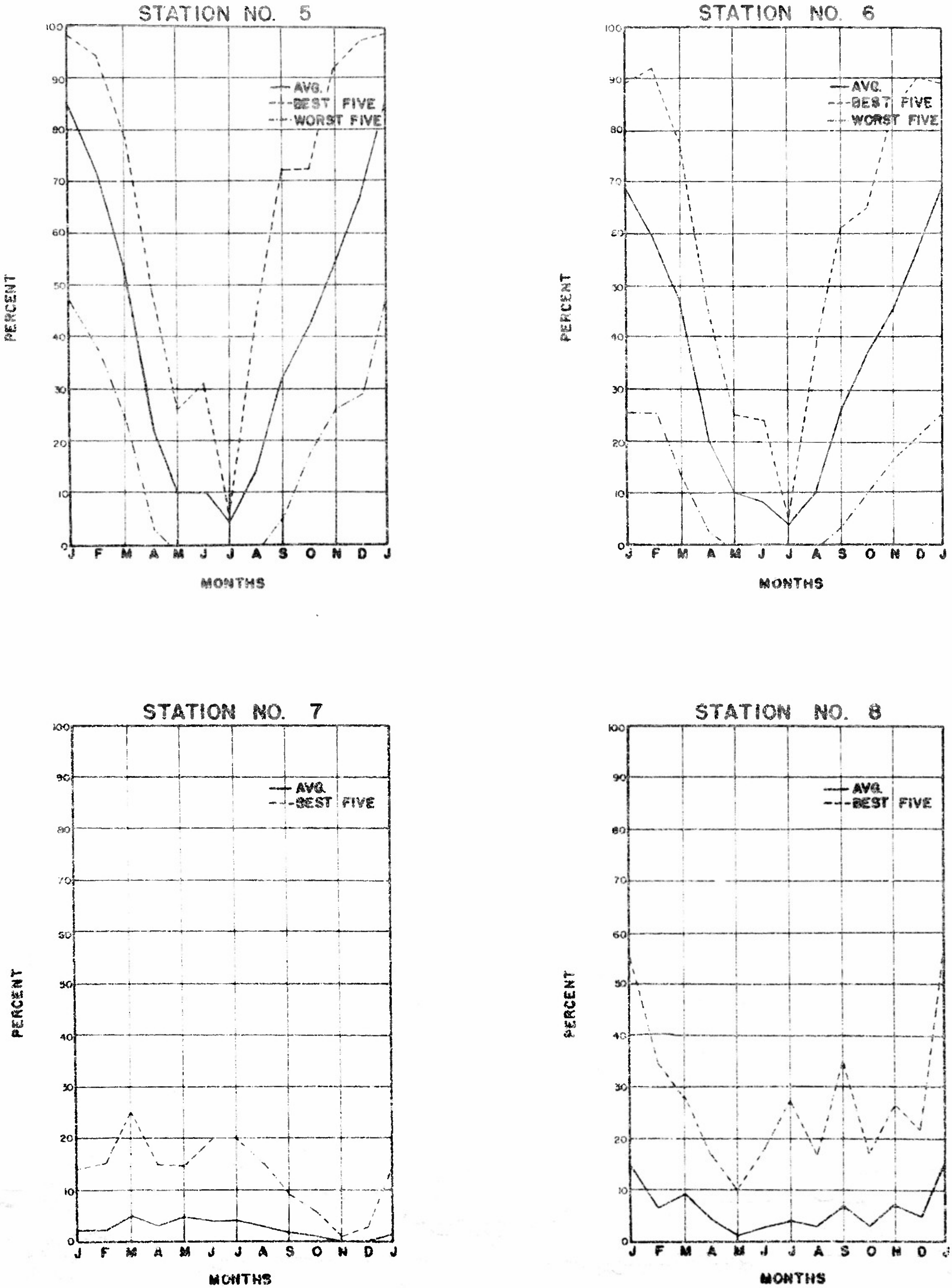





Figure 5: Monthly Probabilities for Stations 5-8.

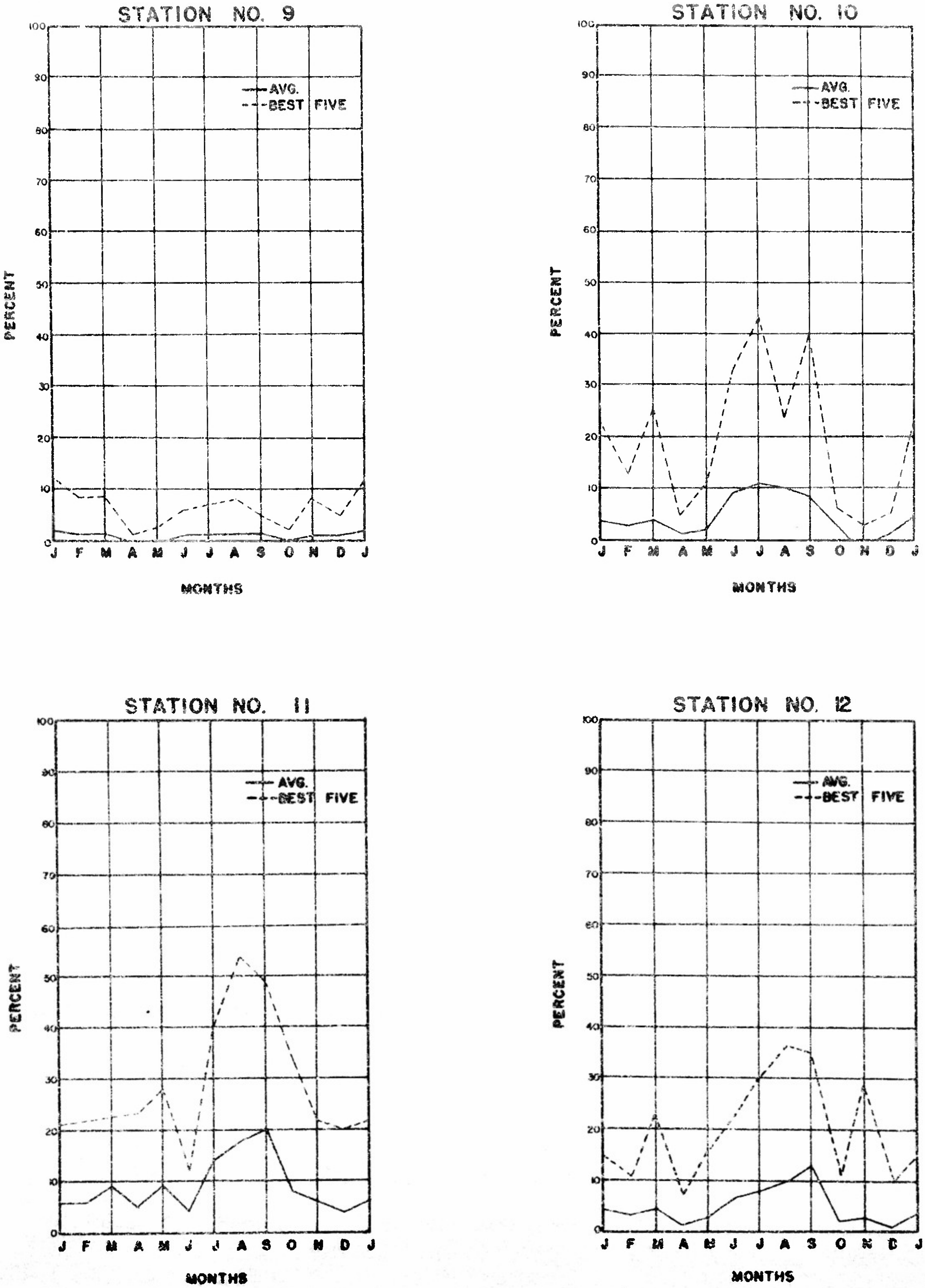



 Figure 6: Monthly Probabilities for Stations 9-12.

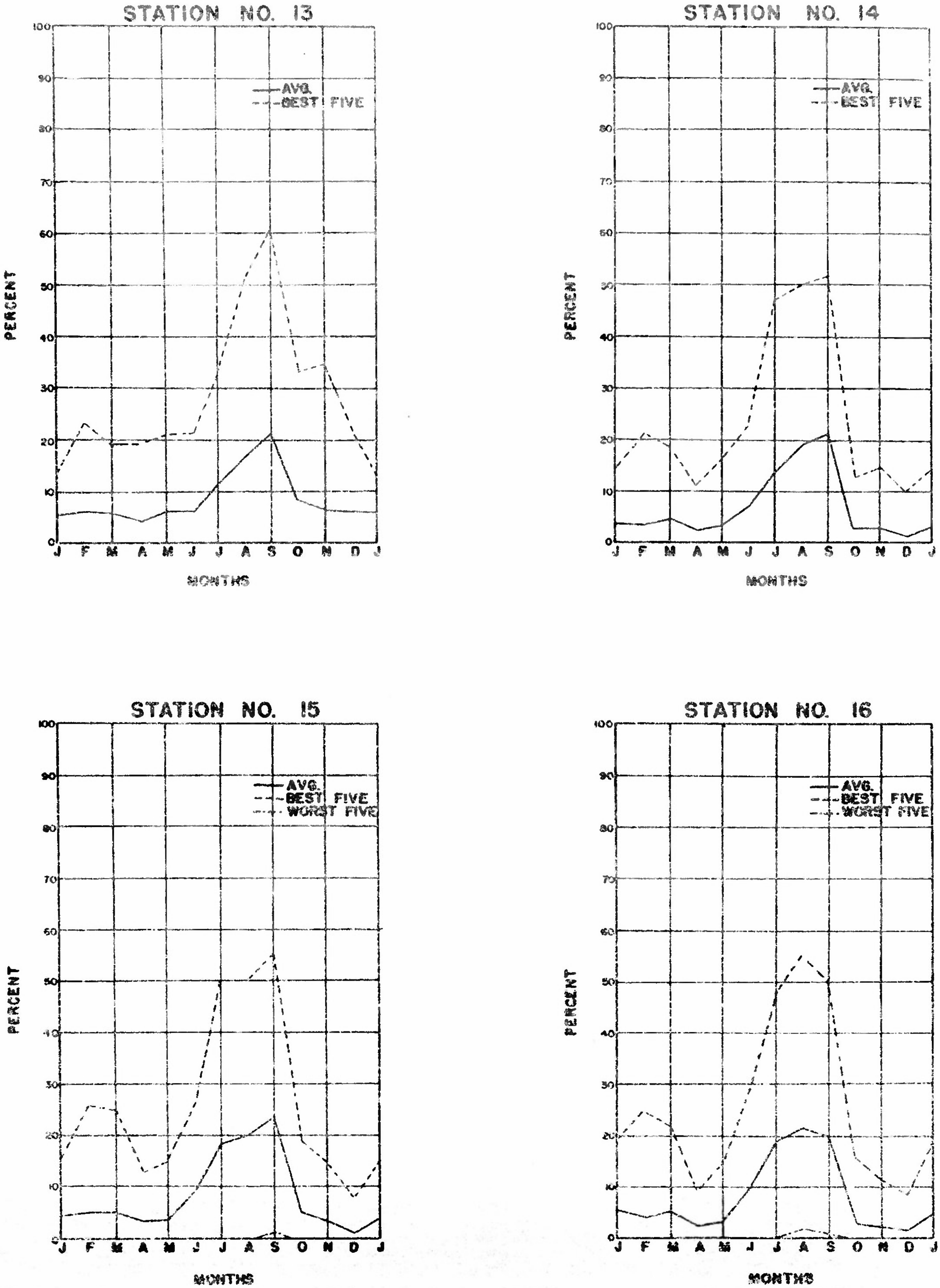



 **Figure 7: Monthly Probabilities for Stations 13-16.**

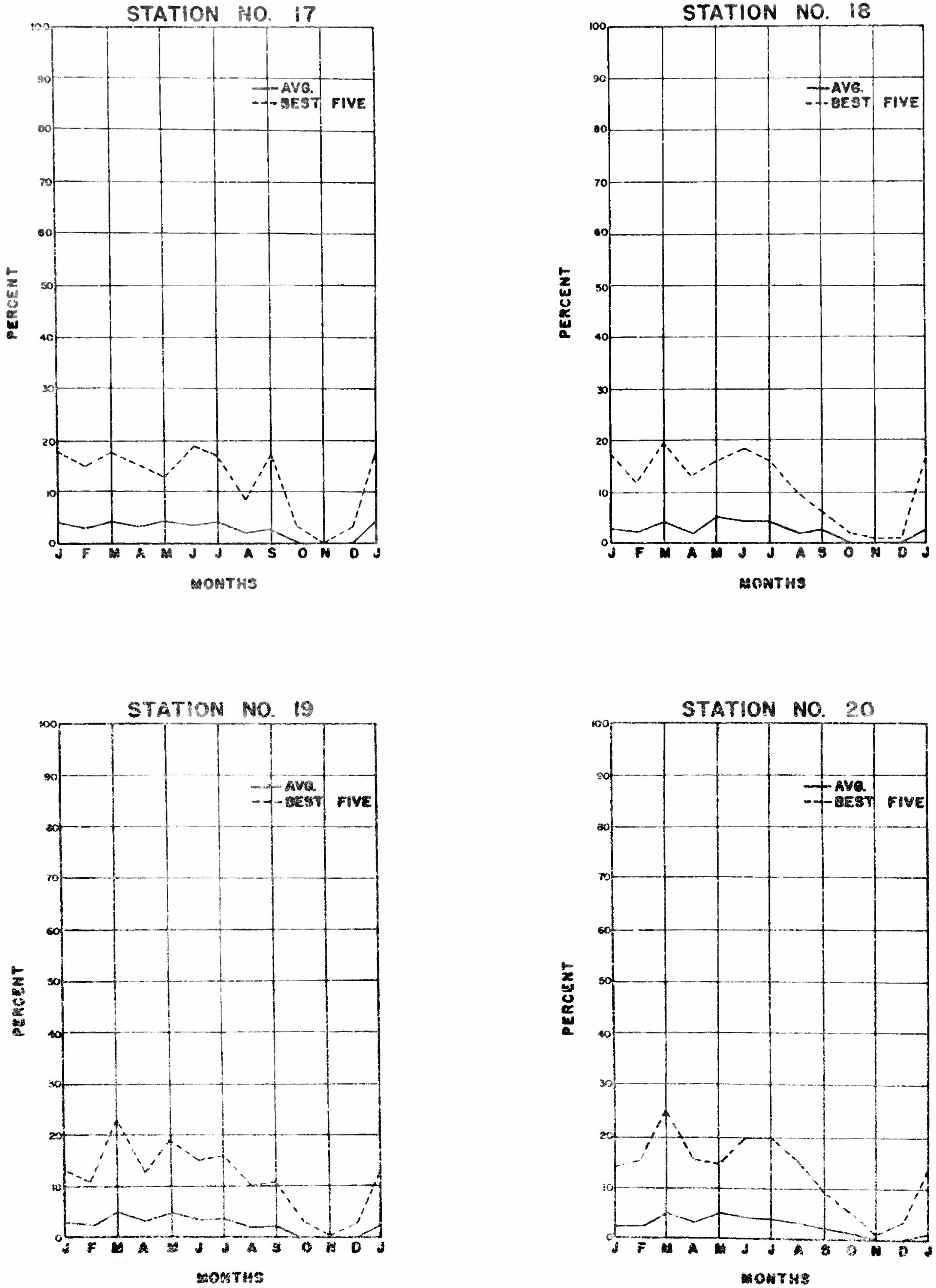
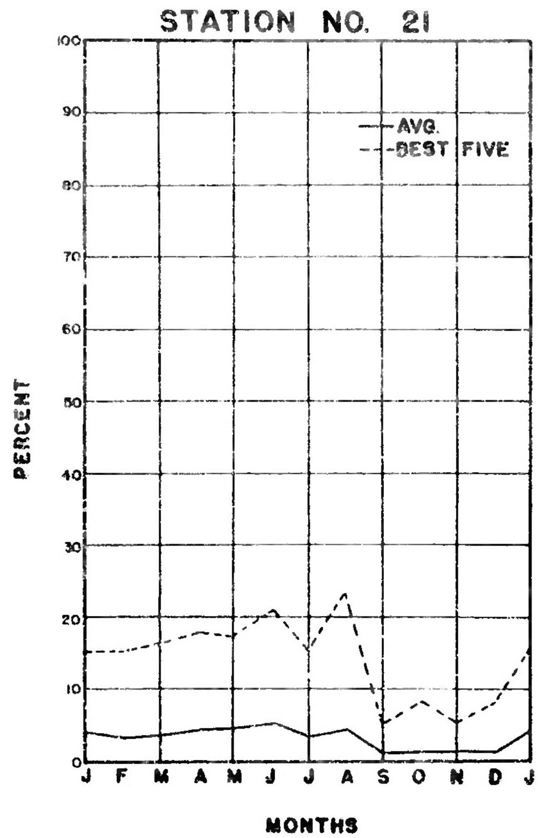





Figure 8: Monthly Probabilities for Stations 17-20.



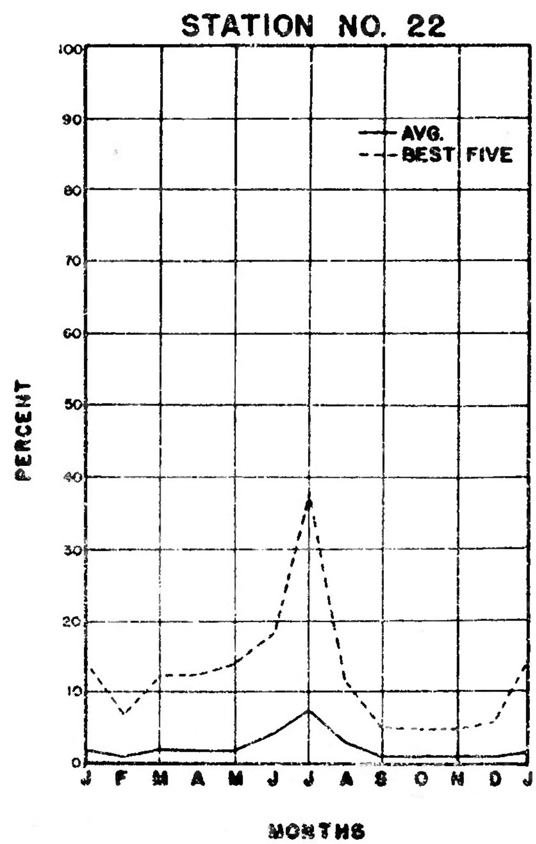




Figure 9: Monthly Probabilities for Stations 21 and 22.

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